SIALOLITHIASIS.[1]

BY O. THEODORE ROBERG, M.D.,

OF CHICAGO, ILLINOIS,

Surgeon to the Swedish Covenant Hospital.

SIALOLITHIASIS is of relatively infrequent occurrence. In 1896, Fütterer[1] was able to collect 160 cases. I have collected forty-seven cases occurring since that time.

The following case was seen by the writer in November, 1902:

Mr. M., aged fifty-eight years, came to me complaining of a large, diffuse, and painful swelling, involving the right side of the neck and lower part of face.

In 1874, for the first time, the patient noticed that a lump appeared in the right submaxillary region when he ate something sour or saw something which caused his mouth to water. The swelling usually attained the size of a walnut, and would remain for from thirty minutes to two hours, disappearing gradually. This occurred from once a week to once or twice a year until 1893, when the swelling appeared and remained for six weeks. Before this there had been very little pain. At this time the floor of the mouth became swollen, reaching to the cutting edge of the lower teeth, and the patient began to have much pain, which was referred to the right side of the lower jaw. Two teeth were extracted, but without relief. There was a good deal of pain and difficulty connected with swallowing, but none with chewing or speaking. He noticed a small amount of pus discharging from under the right side of the tongue, and was told by some physicians that he had a cancer. Dr. Fenger, who was then consulted, removed a pea-sized stone from Wharton's duct, and five days later sutured the opening made into the duct. It is probable that the stone had existed for nineteen years.

After this the patient remained well until August, 1901

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(eight years), when a hard and painful swelling, the size of a hickory-nut, again appeared in the right submaxillary region. During the next six months it increased gradually in size, after which the entire side of the neck began to swell and became painful. In February, 1902, he consulted a doctor, who incised the swelling, giving exit to a large amount of pus. After two weeks the incision had closed. After this, however, the swelling did not disappear entirely, and during the next eight months there were periods during which the swelling became larger and painful, subsiding again in a few days. In October, 1902, the swelling became quite large and very painful. For several weeks following this there was an occasional discharge into the mouth of a sweetish taste. There was a sense of fulness in the mouth, some pain on swallowing, and difficulty in opening the mouth.

Previous History.—He has never been sick in bed. Formerly, he smoked and chewed tobacco excessively, keeping the tobacco in the *right* side of the mouth. His saliva used to flow very freely when he used tobacco. His teeth were in good condition until 1885, when he began to suffer with Rigg's disease. Since that time there has been excessive tartar formation on the teeth. There is no history of infection of the salivary glands, of the mouth, or of tonsillitis.

Family history negative.

On examination, November 25, 1902, the right side of the neck and face was swollen, the swelling reaching as high as the malar bone, and as low down as the clavicle, and it was most prominent in the submaxillary region. The skin over this area was dark red in color and œdematous. On palpation it was somewhat painful. In consistency it was of board-like hardness. There were no areas of softening, nor could any fluctuation be detected. Inspection of the mouth showed no swelling or discoloration of the mucous membrane. There was recession of the gums with considerable tartar formation on the teeth. Digital examination of the floor of the mouth revealed a hard nodule, the size of a large pea, on the right side, opposite the position of the second molar tooth. It was immovable, and felt as if it were attached to the inner surface of the lower maxilla. A needle introduced into the nodule gave exit to a small amount of pus and apparently did not strike any hard body, and the nodule did not diminish in size after the escape of pus. A No.

2 Bowman probe was passed into Wharton's duct as far as the nodule. There was no sensation of contact with a hard body. The left side of the neck was normal and no glands could be felt on either side. Temperature 99° to 100° F. Urine examination, negative.

A diagnosis was made of calculus in Wharton's duct, and probably in the submaxillary gland, with suppuration of the gland and suppurative cellulitis of the neck.

November 26, 1902. I made an incision, under local anæsthesia, into the mass, and a small amount of thick, curdy pus escaped. One week later the swelling was considerably smaller, and pus had ceased to discharge. The patient was then anæsthetized. The nodule in the mouth was incised, and by means of a small curette a concretion the size of a split pea was removed. An incision about three inches long was then made externally, parallel with the lower border of the jaw, and one-half inch below it. By means of blunt dissection through a mass of dense scar tissue the submaxillary gland was exposed and removed. The wound was packed with iodoform gauze, and only partly closed. A second calculus was found lodged in the beginning of the duct.

Five weeks after the operation the wound was completely closed. After the operation there was paresis of the angle of the mouth, from which the patient had completely recovered four months later.

In order to determine whether there was anything in the patient's saliva that would throw light on the etiology of concretions, I collected his saliva and determined the total solids, inorganic solids, and reaction, with the following results:

Total solids, .86 per cent.

Inorganic solids, .28 per cent.

Alkalinity to litmus, first specimen, 5 cubic centimetres saliva required 4 cubic centimetres, n/100 oxalic acid.

Second specimen, 5 cubic centimetres saliva required 7.5 cubic centimetres, n/100 oxalic acid.

Acidity to phenolphthalein, first specimen, 5 cubic centimetres saliva required 2.9 cubic centimetres, n/100 potassium hydroxide.

Second specimen, 5 cubic centimetres saliva required 1.3 cubic centimetres, n/100 potassium hydroxide.

In determinations of normal saliva by Chittenden and Richards,[2] the total solids varied from .32 per cent. to 1.02 per cent., and the inorganic from .15 to .28 per cent.

The reactions as given above also correspond with most analyses. Therefore, in regard to solids and reaction, the saliva is normal.

Description of the Concretions.—The larger concretion is spherical in shape, and measures 6 to 7 millimetres in diameter. It weighs .2 gramme. The smaller is somewhat pyramidal in shape and measures 3 to 4 millimetres in diameter. They are light grayish brown in color. The surface has a cauliflower appearance, except where the stones had been in contact with each other, where there is a facet on each stone. Section of the larger stone shows it to be made up of three parts,—the central a nucleus, a round, hard body which lies in a cavity somewhat larger than the nucleus; next to this cavity are several lamellæ, which can easily be separated from one another; the outer layer is more compact and darker in color. The smaller stone on section is seen to be made up of two parts,—the central soft and spongy, the outer harder and more compact. (See illustrations.)

The gland measures 3.7 centimetres by 2.5 centimetres by 2 centimetres and weighs 8.5 grammes. The mesial surface is quite smooth and free from adhesions, and the external surface is covered with fibrous tissue. It is of cartilaginous hardness, and the cut surface is smooth and glistening. There are numerous pinhead-sized points, which are of a more grayish color, and lack the glistening appearance of the greater part of the gland. Pressure upon the gland causes a thick, yellowish-white fluid to exude from these points. Smears of this fluid show polymorphonuclear leucocytes, degenerated epithelial cells, and an occasional diplococcus. Means were not at hand to make cultures.

Histologic Examination. (By Dr. P. Bassoe.)—"About two-thirds of the sectional area are found to be occupied by a dense old fibrous tissue. Between its bundles, and particularly around the vessels, both large and small, are collections of round cells, most of which possess the morphologic characteristics of plasma cells. Some vessels, however, are not surrounded by such cells. The endothelium of the smaller vessels has participated in the inflammatory proliferation. There are no acini remaining in the section, but many glandular ducts are present and in-

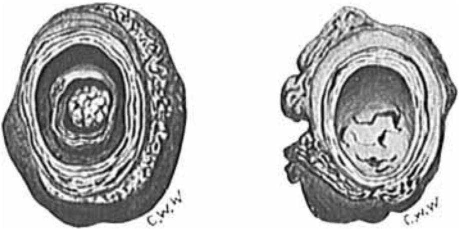

Fig. 1.—Interior of larger calculus, magnified six diameters.

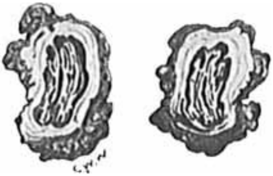

Fig. 2.—Interior of smaller calculus, magnified six diameters.

variably surrounded by large collections of round cells. Their epithelial lining is proliferating, and the lumina contain degenerated epithelial cells and a few polymorphonuclear leucocytes. The latter cell is also seen here and there outside the ducts. In sections stained for bacteria by the Gram-Weigert method, short bacilli are found in small number. They are short, rather thick, generally occur in pairs, and are deeply stained.

"I also examined a slide from another portion of the gland. This contains a larger amount of gland tissue, otherwise it answers to the description given above."

Calculi occur most often between the ages of twenty years and forty years. Burdel[3] reports the occurrence of a calculus in the sublingual duct of a child aged three weeks. There had been difficulty in nursing, and it is reasonable to conclude that it had existed at the time of birth. Men are more often affected than women. Czygan[4] gives the proportion of two to one. Another writer gives five to one. (Duparque and Melian.[4])

Calculi vary in size from that of a grain of sand to one measuring one and one-eighth inch in length and two inches in circumference.[5] The usual size is from that of a split pea to that of a date-stone or hazel-nut. They occur most often singly. In the forty-seven cases collected by the writer there was more than one calculus in seven cases. A large number of small concretions may be discharged from the duct, as in Spencer's[6] case, in which also the submaxillary gland was filled with miliary calculi. Recurrence takes place in a small percentage of cases. Of these forty-seven cases, there were five with recurrence; one had[7] three recurrences in twenty-two years; one, two recurrences, and two, one recurrence.

In shape, the calculi are usually spherical or oval; in the ducts they often become elongated and resemble date-stones. When multiple in the duct they are arranged end to end, and the opposed surfaces are faceted. The surface is finely or coarsely granular and the color is a dirty yellowish gray. Usually the structure and composition are homogeneous. To this there are numerous exceptions, as in the writer's case and others.

Potties[8] reports a case in which the calculus was made up of two parts,—the central consisting of uric acid and a small amount of calcium phosphate and calcium carbonate, the outer part being made up of calcium phosphate and calcium carbonate, about 69 per cent. of the former and 20.1 per cent. of the latter. Galippe has also described concretions which had a laminated structure. In a few cases foreign bodies have been found as nuclei. Calculi are made up mostly of calcium phosphate and calcium carbonate. Some contain ammonio-magnesium phosphate. The following analyses are taken from v. Gorup Besanez.[9]

	I.	II.
Calcium carbonate	81.3	2
Calcium phosphate	4.1	75
Soluble salts	6.2	
Organic matter	7.1	23
Water, etc.	1.3	

The following table shows the relative frequency of the occurrence of calculi in the various glands and ducts:

	In Wharton's Duct.	In Submaxillary Gland.	In Stenson's Duct.
Czygan	22	4	4
Writer's	28	14	2

	In Parotid Gland.	In Sublingual Duct.		In Sublingual Gland.
		D. Rivine.	D. Barth.	
Czygan	1	5	1	0
Writer's	1	0	0	2

Etiology.—The cause of calculus formation in the salivary glands or ducts has been the subject of much discussion. In some of the early reported cases foreign bodies were found within the calculi. Naturally, it was concluded that these were the cause of their formation. The foreign bodies found were pieces of fish-bone, wood, bristle, and a shot. Foreign bodies have been found in only a small percentage of cases. In one case a cavity was found corresponding to a mustard seed, which it was thought had found its way into the duct. This is important, as it indicates that a foreign body can be the cause of a calculus and become disintegrated and disappear. In this connection, it is important to note the occurrence of foreign bodies in the ducts without giving rise to the formation of calculi. Cabot [10] reports a case in which a piece of straw had been lodged in Wharton's duct for six months. In another case [11] there was a piece of hair in Stenson's duct for two months. Cosens [12] reports two cases in which particles of grass had been lodged in the submaxillary duct and sublingual duct,—in the former for eighteen months, and in the latter for four months. In all these cases suppuration took place without the production of calculi. Foreign bodies are found in the ducts more frequently without the production of calculi.

Galippe [13] has made cultures from the interior of the calculi, and has found bacteria in all cases. He concludes, therefore, that bacteria constitute the essential etiological factor. Hartman [14] has likewise found bacteria in smears and cultures. It appears reasonable that bacteria should be a *sine qua non*. But if infection alone were the principal factor, why do not calculi occur more frequently, and why do they not occur most frequently in the gland and duct which are most often the seat of infection, namely, the parotid and its duct?

If bacteria give rise to the formation of the calculi, how do they do so? It is ordinarily stated that saliva undergoes acid fermentation. This is probably true in the presence of carbohydrates, which may be found in the mouth; but we do not expect this to take place in the ducts or glands. I have made a number of experiments, with a view of determining whether the tendency of the saliva is towards acid or alkaline fermentation. With the proper precautions, I have collected saliva into a sterile bottle and determined the degree of alkalinity to litmus and degree of acidity to phenolphthalein. Saliva is usually alkaline to litmus and acid to phenolphthalein, which shows, of course, that the reaction is due to the presence of the hydrogen phosphates and carbonates. In some cases the saliva was allowed to stand at room temperature, and in others it was placed in an incubator for from one to several days. Invariably the degree of alkalinity was increased and the acidity decreased.

Results of determinations in two specimens.

Specimen 1. Fresh. Five cubic centimetres saliva required 4 cubic centimetres n/100 oxalic acid, and 2.9 cubic centimetres n/100 potassium hydroxide.

Same specimen, twenty-four hours later, room temperature, 5 cubic centimetres required 5 cubic centimetres n/100 oxalic acid, and 1.1 cubic centimetres n/100 potassium hydroxide.

Same specimen, seven days old. Five cubic centimetres required 6.2 cubic centimetres n/100 oxalic acid. (Quantity of saliva insufficient to determine acidity.)

Same specimen, nine days old. Five cubic centimetres required 12.5 cubic centimetres n/100 oxalic acid. (Quantity of saliva insufficient to determine acidity.)

Specimen 2. Fresh. Five cubic centimetres required 7.5 cubic centimetres n/100 oxalic acid. 1.3 n/100 potassium hydroxide.

Same specimen, twenty-four hours in incubator. Five cubic centimetres required 9 cubic centimetres n/100 oxalic acid. (Quantity of saliva insufficient to determine acidity.)

This is important, because the calcium phosphate and calcium carbonate, of which the calculi are made up, are rendered insoluble by the increase in the degree of alkalinity. It requires very little change in the composition of saliva to cause a precipitation of the calcium salts. If saliva is exposed to the air for a short time, CO_2 escapes, and a thin film forms on the surface, which on examination is found to be calcium carbonate. Hence the removal of CO_2 alone is sufficient to precipitate the calcium salts. When the bacteria decompose the proteids in the saliva, ammonia is produced, which probably immediately unites with the CO_2 held in solution, and we promptly have the conditions favorable for calculus formation. From this it is reasonable to conclude that the bacteria cause a precipitation of the calcium salts of the saliva by increasing the alkalinity of the saliva and removing the CO_2, as explained above. But this does not explain why calculi are found so much more frequently in the submaxillary gland and its duct than in the others.

Obstruction to the outflow of saliva, retention and consequent thickening of the saliva, have been given to explain the formation of salivary calculi. Salivary cysts are less frequent than salivary calculi; in fact, they are quite rare. In the cases of salivary cysts which I have found reported, in only one was there a deposition of the insoluble salts, and that was in a parotid duct cyst.[15] Salivary cysts of Wharton's duct are the least frequent, while, as we have seen, calculi occur there most often.

Loveland[16] reports a case of occlusion of Stenson's ducts in a middle-aged woman, which probably dated back to an attack of diphtheria at the age of thirteen years. Here was a case of retention of saliva for years without any concretions forming.

Skirving[17] reports a case of shorter duration, with thickened and viscid saliva, without any concretions. It is improbable that salivary cysts are an important etiological factor.

We naturally ask, Why do calculi occur so much more frequently in the submaxillary gland and its duct? We must explain this fact by either the anatomical conditions of the duct or the composition of the submaxillary saliva, as differing from that of the other glands. As factors predisposing to a precipitation of the calcium salts, we will mention a high percentage of solids, high percentage of organic matter, greater degree of alkalinity, and a low content of CO_2. The sublingual saliva contains more total solids, more organic matter, more mucin, and has a higher degree of alkalinity than the saliva of the parotid and submaxillary glands. The amount of CO_2 is about the same in all the salivas. Therefore, if the composition of the saliva should determine where the concretions would most likely occur, they would occur in the sublingual gland and its duct. As a matter of fact, the occurrence of a stone in the sublingual gland and its duct is rare. We must therefore look to the anatomical conditions for an explanation of the greater frequency of occurrence of calculi in the submaxillary gland and its duct. If we exclude stasis of the saliva as an important cause of calculus formation, the length of duct and direction of duct, whether upward or downward, are of little significance.

In what way could the anatomical conditions favor the production of calculi? It is admitted that bacteria are an essential etiological factor. We have stated that the parotid gland is the one most often the seat of infection. Inflammation of the ducts also occurs in the absence of infection of the glands. According to Küttner,[18] inflammation of Stenson's duct is most frequent. If we admit the bacterial origin, alone, of the calculi, the anatomy of Wharton's duct does not explain why the greater proportion of calculi are found there. Foreign bodies are found in Wharton's duct more often than in the others. Of seven cases of foreign bodies in the ducts which I have found reported, four were found in Wharton's duct, two in Stenson's duct, and one in the sublingual duct.

From the foregoing, it appears that something in addition to bacteria is necessary to explain the production of calculi. To me that something appears to be a foreign body. Foreign bodies, particles of tartar and food can enter Wharton's duct more readily than the others, because of the greater size and the location of the orifice. The composition of tartar is very similar to that of the calculi. Therefore, although tartar might often be a determining factor, we would be unable to demonstrate it. Food particles might easily undergo decomposition and simply add to the percentage of organic matter in the calculus. The question arises whether a constitutional condition can in any way predispose to calculus formation. If a general cause were at all active, we would expect it to exert an influence upon more than one gland in a given case, and give rise to calculi in the several glands or ducts. In only one case[19] have calculi been found in more than one gland or duct in the same person. It appears probable that an increase in the total solids of the saliva may be a predisposing factor. Langley and Fletcher[20] have shown that the salts of saliva increase directly with the rate of secretion.

Ballard[21] reports a case in which calculi were discharged five years after the patient was salivated during an attack of jaundice. In the writer's case there is a history of excessive flow of saliva caused by the use of tobacco.

The symptoms of salivary calculus are determined by the size of the calculus, its location, and the occurrence of suppuration. In the absence of suppuration, a calculus may exist for years without much disturbance. There are cases on record in which calculi have existed for fourteen, twenty-eight, and even forty years.[22] [23] [24] [25] The most characteristic symptom of calculus in Wharton's duct, and usually the earliest, is the so-called "salivary colic" of the French, characterized by intermittent retention of saliva, and accompanied by more or less pain and discomfort. This retention of saliva, with the formation of a swelling in the floor of the mouth and in the submaxillary region, usually comes on when eating, and remains for one or several hours, disappearing gradually. Or it may be made to disappear by pressing upon it, expressing the retained saliva into the mouth. This swelling may come and go for years, as in the writer's case, until suppuration occurs, when the swelling becomes more or less permanent. The retention is not determined entirely by the size of the calculus. Weber[26] reports a case in which a concretion the size of a mustard seed caused retention, while there are some cases with a calculus the size of a cherry-stone or date-stone, in which there have been no symptoms of retention.

The patient may be aware of the presence of a hard nodule in the mouth. There is usually some difficulty in chewing, swallowing, and speaking; at times, chewing and swallowing may be almost impossible. It may be difficult to open the mouth. The swelling in the floor of the mouth may reach the cutting edge of the teeth. Freudenthal[27] reports a case in which the abscess became so large that death resulted from asphyxiation. The abscess frequently bursts into the mouth, often discharging the calculus also. If only one calculus has been present, a cure results. Sometimes the stone causes a pressure necrosis of the overlying tissues, escaping through the opening thus made. In rare cases[7] the calculus may be discharged through the normal orifice of the duct. Winslow[28] reports a case in which he found a calculus in a swelling directly over the larynx. Several months before, the patient had noticed a swelling underneath the tongue, which had disappeared spontaneously. With suppuration in the duct, there is usually infection also of the gland, giving rise to a painful swelling of the submaxillary gland.

When the calculus occurs in the submaxillary gland, the gland enlarges and becomes firm in consistency and tender to palpation. The gland may remain slightly enlarged and tender to the touch for years; it increases slowly in size, and usually becomes more painful. There are periods when the gland swells acutely and becomes very painful, to subside again to its former condition. Eventually a suppurative cellulitis of the neck may supervene, and a diffuse phlegmon involving the greater part of the side of the neck and face develops, resembling a case of Ludwig's angina. Even this may subside, as happened in the writer's case, to return at a later date. If not opened, it may burst spontaneously. In some cases a fistula results, discharging pus and concretions.[29]

In twenty-seven cases of fistula of Stenson's duct discharging saliva, as given by Duplay and Reclus,[30] three were caused by calculi. I have not found a salivary fistula of the other ducts or glands caused by calculi.

The constitutional effects of salivary calculi are usually slight.

Diagnosis.—A diagnosis of salivary calculus is easily made when there is a history of "salivary colic," followed by an inflammatory swelling in the floor of the mouth. The calculus can often be detected by sounding the duct. Retention of saliva and suppuration can be caused by foreign bodies in the ducts, or by an inflammation of the duct in the absence of any foreign body. An abscess in the floor of the mouth, in the absence of a history of retention of saliva, may suggest an alveolar abscess. The abscess which develops about the submaxillary gland is very easily mistaken for an alveolar abscess if a good history is not obtained. When the calculus occurs in the gland, it may be difficult to arrive at the correct diagnosis. A gradual enlargement, with periods of acute inflammatory symptoms, suggests a calculus. Syphilis, tuberculosis, actinomycosis, malignant disease, and the "inflammatory swelling" of Küttner[31] must be considered. A large percentage of the cases are diagnosed malignant disease.

In a case reported by Gerota,[32] a calculus in the submaxillary gland was detected by the X-ray.

Treatment.—The indications are to evacuate the abscess, remove the calculus, and in some cases to extirpate the gland. When a stone is located in the duct, it should be removed through the mouth. This can usually be done with local anæsthesia. However, at times bleeding is very free, and the stone is so difficult of removal that a general anæsthetic becomes necessary. In some cases the granular surface of the calculus is very firmly adherent to the surrounding tissues, making its removal somewhat difficult. The removal of stones in Stenson's duct through the mouth may be impossible. Solé [33] removed six calculi from Stenson's duct from the outside, suturing the duct, and obtained healing by primary intention, without any salivary fistula. Fenger was in the habit of suturing the opening made into Wharton's duct, although made from inside the mouth. If a gland has been the seat of infection secondary to a calculus in the duct, even for a long time, the enlarged gland becomes normal in size in from one to two weeks after the removal of the calculus.[10]

If the submaxillary or sublingual gland is thought to be the seat of a calculus, it must be reached from the outside. After exposure of the gland, it is incised. If a single calculus is found and the gland not much changed, the calculus can be removed and the gland left. If the calculi are multiple and difficult to remove, or the gland is the seat of miliary abscesses, it is well to extirpate the gland.

In case of calculus of the parotid gland, incision, removal of the calculus and drainage are, of course, all that could be done.

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